

What is claimed is:

1. A process to provide, retain and employ electronic charge injection to substantially change the properties of an article, the process comprising the steps of:

- (a) providing an article A, wherein the article A is selected from the group consisting of a largely electrolyte-free porous electrode region, at least one particle, and combinations thereof;
- (b) immersing article A into an electrolyte E;
- (c) providing an ion conducting and substantially electronically insulating continuous path between article A and a counter-electrode B;
- (d) applying a potential between article A and the counter electrode B for sufficient time that substantial electronic charge is predominately non-faradaically injected into article A to form a charge-injected article A; and
- (e) substantially removing the electrolyte E from contact with charge-injected article A;

wherein both the article A and the counter electrode B have an electronically conducting state selected from the group consisting of charged, uncharged, and combinations thereof, and wherein the article A has an achievable capacitance for non-faradaic charging of at least about 0.1 F/g.

2. The process of claim 1, wherein step (d) further comprises the steps of:

- (i) removing charge from article A by applying a series of potentials; and
- (ii) re-injecting charge into article A, so as to thereby increase the gravimetric capacitance of article A.

3. The process of claim 2, wherein the steps of removing and re-injecting electronic charge into article A are carried out at least three times prior to performing step (e), so as to further enhance the gravimetric capacitance of article A.

4. The process of claim 1, wherein the article A is a single particle that is dispersed in the electrolyte E with particles that are similar to article A, and wherein

the potential is applied when article A makes at least intermittent contact with an electrode in the presence of the electrolyte E.

5. The process of claim 4, wherein the single particle is a fiber.

6. The process of claim 4, wherein the at least intermittent contact is made by a sub-process selected from the group consisting of using gravity, together with a density difference between the single particle and the electrolyte; a moving conducting belt electrode that carries the particle into and out of the bath; electrolyte flow; and combinations thereof.

7. The process of claim 4, wherein said at least intermittent contact is made with a working electrode, and not with the opposing electrode, by using a separator between the working electrode and counter electrode B that is substantially impermeable to the single particle and like particles.

8. The process of claim 4, wherein the single particle is a semiconductor particle that is smaller than 200 microns in its smallest dimension.

9. The process of claim 1, wherein the article A is most of an electrode that is the major opposing electrode to said counter electrode B.

10. The process of claim 9, wherein said counter electrode B has a gravimetric capacitance above about 0.1 F/g, and wherein step (e) additionally includes removing the electrolyte E from contact with a majority part of counter electrode B.

11. The process of claim 10, wherein both the article A and said counter electrode B have a capacitance above about 10 F/g.

12. The process of claim 11, wherein said process is operable for the manufacture of a supercapacitor.

13. The process of claim 12, further comprising making a device electrode for an electrical energy storage device that discharges like supercapacitor and at least partially stores energy like a battery by laterally interconnecting at least one sheet of an article A and at least one sheet of a predominately faradaically charged material.

14. The process of claim 12, further comprising making a device electrode for an electrical energy storage device that discharges like supercapacitor and at least partially stores energy like a battery by dispersing the a component that is predominately faradaically charged within a matrix that can be predominately non-faradaically charged.

15. The process of claim 13, wherein the gravimetric surface area of a sheet of article A is at least ten times that of a predominately faradaically charged sheet.
16. The process of claim 12, further comprising a subsequent immersion of article A into an electrolyte to form an immersed electrode, wherein there is also immersed in the electrolyte either counter electrode B, or a different counter electrode.
17. The process of claim 1, wherein both the article A and the counter electrode B have an electrical conductivity above 1 S/cm in both their charged and uncharged states.
18. The process of claim 1, wherein the article A comprises material with a property selected from the group consisting of ferromagnetism, antiferromagnetism, superconductivity, and combinations thereof; in its charged state.
19. The process of claim 1, wherein the article A comprises material with a property selected from the group consisting of ferromagnetism, antiferromagnetism, superconductivity, and combinations thereof; in its uncharged state.
20. The process of claim 1, wherein the article A, in a state selected from the group consisting of charged, uncharged, and combinations thereof; comprises energetic material operable for use in a role selected from the group consisting of an explosive, an explosives initiator, a propellant, a propellant initiator, heating purposes, and combinations thereof.
21. The process of claim 20, further comprising the steps of bringing together the article A with a differently charged electrode component so as to serve a function selected from the group consisting of initiate an explosion, initiate the burning of a propellant, *increase the energy released in an explosion*, increase the energy released during the burning of a propellant, increase the energy released by a heating element, and combinations thereof.
22. The process of claim 20, further comprising a step of incorporating the article A into an article of clothing for heating purposes.
23. The process of claim 20, wherein the article A comprises spun, electronically conducting fibers.
24. The process of claim 1, further comprising subsequent exposure of the article A to a material that can be adsorbed.
25. The process of claim 24, wherein said material comprises hydrogen.

26. The process of claim 1, wherein the electrolyte E comprises a biochemically active agent, and wherein this active agent is deposited and substantially retained within article A.

27. The process of claim 26, wherein the biochemically active agent comprises a species selected from the group consisting of DNA, RNA, polypeptides, and combinations thereof.

28. The process of claim 27, wherein the polypeptides comprise a species selected from the group consisting of an antibodies, enzymes, aptamers, and combinations thereof.

29. The process of claim 26, wherein article A is a particle that is subsequently injected into a mammalian subject as a carrier for the biochemically active agent.

30. The process of claim 29, wherein said biochemical agent is released in the mammalian subject as a result of exposing article A to actinic radiation.

31. The process of claim 30, wherein the actinic radiation is infrared radiation of a frequency transparent to the mammal body.

32. The process of claim 1, wherein step (e) further comprises a step of washing article A with an electronically insulating liquid L having a property selected from the group consisting of miscibility with the electrolyte E, a capability of dissolving ions of said electrolyte E, and combinations thereof.

33. The process of claim 32, wherein liquid L is substantially free of a salt.

34. The process of claim 32, wherein liquid L comprises a salt, and wherein ions of said salt act in a manner selected from the group consisting of substantially replacing ions associated with the charge injected state of article A, reacting with these ions to provide a new ion type, and combinations thereof.

35. The process of claim 34, wherein salt comprises a component selected from the group consisting of a biochemically active species; a biochemically active precursor species capable of being converted to a biochemically active species, and combinations thereof.

36. The process of claim 32, wherein either liquid L comprises a component selected from the group consisting of a biochemically active species; a biochemically active precursor species capable of being converted to a biochemically active species, and combinations thereof.

37. The process of claim 36, wherein liquid L comprises a species selected from the group consisting of DNA, RNA, a polypeptide, and combinations thereof.

38. The process of claim 37 wherein said polypeptide is selected from the group consisting of antibodies, enzymes, aptamers, and combinations thereof.

39. The process of claim 33 or 34, further comprising a step of drying article A that occurs after the step of washing article A with a liquid L, wherein volatile components of liquid L are substantially removed.

40. The process of claim 33 or 34, wherein a liquid L2 is subjected to an action selected from the group consisting of (1) maintained in intimate contact with article A at the end of said step of washing with a liquid L; (2) used to wash L from article A; (3) placed in intimate contact with article A after the optional drying step, wherein volatilizable components of liquid L are substantially removed; and combinations thereof.

41. The process of claim 40, wherein said liquid L2 comprises a monomer that is capable of polymerization, and wherein liquid L2 is substantially polymerized while in intimate contact with article A.

42. The process of claim 40, wherein said liquid L2 is at least partially solid at room temperature and liquid above a higher temperature T_o , and wherein said liquid L2 is solidified while in intimate contact with article A.

43. The process of claim 40, wherein liquid L2 comprises a composition selected from the group consisting of substantially the same as liquid L, identical to L, and combinations thereof.

44. The process of claim 40, wherein liquid L2 comprises a salt that confers biochemical activity.

45. The process of claim 1, wherein article A comprises a material region with a thickness that is at most about one centimeter.

46. The process of claim 45, wherein the thickness of the material region is at most about 1000 microns.

47. The process of claim 46, wherein the thickness of the material region is at least about 10 microns.

48. The process of claim 1, wherein resistance compensation is used in step (d) to accelerate the rate at which charge is injected.

49. The process of claim 1, wherein the article A comprises a substance selected from the group consisting of nanofibers, an aggregate of electronically conducting particles, a direct-lattice photonic crystal that is electronically conducting, an inverse-lattice photonic crystal that is electronically conducting, and combinations thereof.
50. The process of claim 49, wherein the article A comprises nanotubes.
51. The process of claim 50, wherein said nanotubes are overcoated with a second material having an electrical property selected from the group consisting of insulating, semiconducting, conducting, and combinations thereof.
52. The process of claim 50, wherein said nanotubes are at least partially filled with a material selected from the group consisting of a metal, a semiconductor, an insulator, and combinations thereof.
53. The process of claim 50, wherein said nanotubes are configured as a porous sheet or a porous fiber.
54. The process of claim 50, wherein said nanotubes comprise carbon nanotubes.
55. The process of claim 1, wherein the article A is a particle.
56. The process of claim 1, wherein the article A has a gravimetric capacitance of at least 1 F/g.
57. The process of claim 56, wherein the article A has a gravimetric capacitance of at least 10 F/g.
58. The process of claim 1, wherein the article A largely comprises a porous yarn, the yarn comprising carbon-based nanotubes.
59. The process of claim 1, further comprising a subsequent step of placing a getter material in physical contact with the charge-injected article A so that electrochemical potential of the getter material substantially determines the electrochemical properties of the charge-injected article A, wherein said getter material is a material capable of undergoing redox reaction with the charge-injected article A, and wherein said redox reaction is electron donation if the charge-injected article A is electron injected, and hole donation if the charge-injected article A is hole injected.
60. The process of claim 1, further comprising a subsequent step of placing a getter material in the environment of the charge-injected article A, wherein said

getter material and components thereof do not make physical contact with the charge-injected article A, and wherein said getter material is a composition that is able to undergo redox reactions with species that would otherwise be able to undergo redox reactions with the charge injected material.

61. The process of claim 59 or 60, wherein said getter material comprises material selected from the group consisting of alkali metal, alkali metal alloy, donor intercalated material, acceptor intercalated material, and combinations thereof.

62. The process of claim 56, wherein the article A has a surface area of at least about 1 m²/g.

63. The process of claim 62, wherein the article A has a surface area of at least about 10 m²/g.

64. The process of claim 1, wherein step (e) additionally comprises a step of exposing the charge-injected article A to a material MA that functions to act in a manner selected from the group consisting of significantly replacing ions of electrolyte E with ions of material MA, significantly combining ions of electrolyte E with a component of material MA, and combinations thereof.

65. The process of claim 64, wherein MA comprises a biologically active agent.

66. The process of claim 64, further comprising an additional step of substantially removing from charge-injected article A material MA that is not bound.

67. The process of claim 65, further comprising the steps of substantially removing material MA that is not bound to the charge-injected article A; and subsequently immersing charge-injected article A in a substantially biocompatible liquid.

68. The process of claim 67, wherein the substantially biocompatible liquid comprises normal saline solution.

69. The process of claim 64, wherein the material MA comprises a material selected from the group consisting of DNA, RNA, a polypeptide, and combinations thereof.

70. The process of claim 65, further comprising a subsequent step of delivering the charge-injected article A to a mammalian body, so that the biologically active agent can be released by any combination of exposure to redox active materials present in the mammalian body, exposure to actinic radiation, the application of an

electrical potential that causes current flow that decreases charge injection, and heating.

71. The process of claim 70, wherein the actinic radiation is in the region of the infrared spectrum where the mammalian body has high transparency.

72. The process of claim 64, wherein the material MA is radioactive.

73. The process of claim 1, further comprising using the article A in a manner selected from the group consisting of as a scaffold for tissue growth; as a coating on a device that is implanted in a mammal; and combinations thereof.

74. A composition made by a process comprising the steps of:

- (a) providing an article A, wherein the article is selected from the group consisting of a largely electrolyte-free porous electrode region, at least one particle, and combinations thereof;
- (b) immersing article A into an electrolyte E;
- (c) providing an ion conducting and substantially electronically insulating continuous path between article A and a counter-electrode B;
- (d) applying a potential between article A and the counter electrode B for sufficient time that substantial electronic charge is predominately non-faradaically injected into article A to form a charge-injected article A; and
- (e) substantially removing the electrolyte E from contact with charge-injected article A;

wherein both the article A and the counter electrode B have an electronically conducting state selected from the group consisting of charged, uncharged, and combinations thereof, and wherein the article A has an achievable capacitance for non-faradaic charging of above about 0.1 F/g.

75. The composition of claim 74, wherein said composition comprises, when maintained in a suitable environment, non-faradaically injected charge, substantially no residual electrolyte, and a potential that deviates in magnitude from the potential of zero charge by at least 0.1 volt.

76. The composition of claim 74, wherein said composition comprises a state selected from the group consisting of ferromagnetic, antiferromagnetic, superconducting, and combinations thereof.

77. The composition of claim 74, wherein said composition maintains, in a suitable environment, a potential that deviates in magnitude from the potential of zero charge by at least 0.4 volt.

78. The composition of claim 74, wherein said composition is at least about a micron in the shortest external dimension and comprises at least about 50% pore volume.

79. The composition of claim 74, wherein said composition is at least about one micron in all three external dimensions.

80. The composition of claim 74, wherein said composition comprises nanotubes.

81. The composition of claim 80, wherein said nanotubes are at least partially internally filled.

82. The composition of claim 80, wherein said nanotubes are coated with another material.

83. The composition of claim 74, wherein said composition is optically transparent and electronically conducting.

84. The composition of claim 83, wherein said composition comprises percolated charge-injected nanoparticles, such as nanofibers, that are incorporated in a substantially inert matrix.

85. The composition of claim 83, wherein said composition is a contacting material operable for use in a device selected from the group consisting of a liquid crystal display, light emitting display, solar cell, switchable transparency window, solar cell, micro laser, optical modulator, optical polarizer, and combinations thereof.

86. The composition of claim 80, wherein said nanotubes comprise carbon nanotubes.

87. The composition of claim 74, wherein said composition is in the form of a carbon nanotube yarn, wherein this carbon nanotube yarn is subsequently overcoated with an insulating material.

88. A device having tunable response that comprises:

- (a) a nanostructured electrode component C of a first electrochemical electrode and an electrode component D of a second electrochemical electrode;

(b) an ionically conducting material that is substantially electronically non-conducting that connects said first and said second electrochemical electrodes; and

(c) a means of providing a voltage between said first and said second electrochemical electrodes,

wherein the electrode component C is not in direct contact with an electrolyte, wherein the electrode component C has an achievable capacitance of above about 0.1 F/g for substantially non-faradaic charging, wherein the major volume fraction of C does not function predominately as a catalyst, and wherein properties changes of the electrode component C in response to predominately non-faradaically injected charge are used to achieve device performance.

89. The device of claim 88, wherein the device is operable for providing function selected from the group consisting of electromechanical actuation; the controlled storage and release of synthetic materials; the controlled storage and release of biologically-derived materials; conversion of mechanical energy to electrical energy; conversion of photonic energy to electrical energy; conversion of electrical energy to mechanical energy; conversion of electrical energy to mechanical displacement; conversion of thermal energy to electrical energy using effects selected from the group consisting of thermoelectric, thermoelectrochemical, thermoionic, and combinations thereof; conversion of chemical energy to electrical energy in a fuel cell; stress sensing; strain sensing; tuning of friction; tuning of thermal conductivity; regulation of membrane transport; electron emission; ion emission; tunable change in optical transmission of electromagnetic radiation of frequency regions selected from the group consisting of microwave, radiofrequency, infrared, visible, and ultraviolet; tunable change in optical absorption of electromagnetic radiation of frequency regions selected from the group consisting of microwave, radiofrequency, infrared, visible, and ultraviolet; tunable change in magnetic properties; tunable change in superconducting properties; chemical sensing; biochemical sensing; and combinations thereof, wherein the device response is at least partially effected by a change in the degree of non-faradaic charge injection in the electrode component C.

90. The device of claim 88, wherein the device operates predominately by the transfer of ions between said first and said second electrode.

91. The device of claim 88, wherein the device operates predominately via the transfer of ions in the electrolyte to ions in an electrochemical double layer on the electrodes.

92. The device of claim 89, wherein the device is operable for use as an electromechanical actuator.

93. The device of claim 92 wherein the device is an actuator based on multiwalled nanotubes, wherein non-faradaic charge injection causes the multiwalled carbon nanotube to provide actuation via a telescoping process in which component nanotubes are extruded from a multi-walled nanotube structure.

94. The device of claim 88, wherein the device is used as a sensor for nanoprobe microscopy, wherein charge-injection-based tuning of the electrode component C can be used for (a) tunneling-based imaging; (b) force-based imaging using forces selected from the group consisting of magnetic forces, electrostatic forces, and combinations thereof; and (c) combinations thereof.

95. The device of claim 94, wherein double-layer charge injection in the absence of a contacting electrolyte causes a work function change of the nanoprobe, and thereby effects tunneling-based imaging in a tunable manner.

96. The device of claim 88, wherein the ionically conducting material indirectly connects said first and said second electrochemical electrodes by forming an inter-electrode ion path segment, and wherein the remaining ion path between first and second electrodes involves a pathway provider selected from the group consisting of a separate second electrolyte, an ionically conducting that is electronically conducting material, and combinations thereof.

97. The device of claim 88 wherein a major volume fraction of C is not metal.

98. The device of claim 88, wherein the ionically conducting material comprises a liquid electrolyte.

99. The device of claim 88, wherein said ionically conducting material is not a ceramic electrolyte.

100. The device of claim 88, wherein said device functions, at least in part, in response to application of an electrical voltage between said first and second electrochemical electrodes.

101. The device of claim 88, wherein the electrode component C comprises a substance selected from the group consisting of nanofibers, an aggregate of

electronically conducting particles, a direct lattice photonic crystal that is electronically conducting, an inverse lattice photonic crystal that is electronically conducting, and combinations thereof.

102. The device of claim 101, wherein the electrode component C comprises nanofibers of composition selected from the group consisting of GaAs, GaP, InAs, InP, ZnS, ZnSe, CdS, CdSe, a SiGe alloy, Si, and combinations thereof, and doped combinations thereof.

103. The device of claim 88, wherein an electrode comprises a material selected from the group consisting of WSe₂, MoS₂, MoSe₂, HfS₂, SnS₂, NbSe₂, and combinations thereof.

104. The device of claim 100, wherein the electrode component C comprises nanofibers that comprise single crystal nanofibers.

105. The device of claim 101, wherein electrode component C comprises nanofibers having the approximate composition Mo₆S_{9-x}I_x, wherein x is approximately between 4.5 and 6.

106. The device of claim 101, wherein electrode component C comprises electronically conducting particles, wherein these electronically conducting particles are selected from the group consisting of an elemental metal, an elemental metal alloy, a substance coated with an elemental metal, a substance coated with an elemental metal alloy, and combinations thereof; and wherein these electronically conducting particles are percolated with themselves to provide a continuous path for electronic conductivity within the electrode component C.

107. The device of claim 106, wherein said electronically conducting particles are configured as a photonic crystal.

108. The device of claim 107, wherein the photonic crystal is an electronically conducting inverse-lattice photonic crystal.

109. The device of claim 101, wherein said nanofibers in electrode component C comprise a substance selected from the group consisting of single-wall carbon nanotubes, multi-wall carbon nanotubes, scrolled carbon-containing nanotubes, and combinations thereof.

110. The device of claim 109, wherein said nanotubes comprise nanotubes that are at least partially filled internally with another material.

111. The device of claim 109, wherein said nanotubes comprise nanotubes that are at least partially coated externally with another material.

112. The device of claim 110 or 11, wherein another material undergoes charge transfer with the nanotubes.

113. The device of claim 88, wherein each of the first and second electrochemical electrodes comprise a substance selected from the group consisting of nanofibers, a direct-lattice photonic crystal that is electronically conducting, an inverse-lattice photonic crystal that is electronically conducting, and combinations thereof.

114. The device of claim 88, wherein charge injected non-faradaically in electrode component C does not subsequently cause substantial intercalation of material component C.

115. The device of claim 88, wherein each of said first electrochemical electrode and said second electrochemical electrode have a maximum achievable electronic conductivity of at least about 1 S/cm, and wherein the ratio of the maximum electronic conductivity of a highest conductivity electrode to the electronic conductivity of the electrolyte that is ionically conducting and electronically insulating is at least about 10^5 .

116. The device of claim 88, wherein exactly one of said first and said second electrochemical electrodes is capable of undergoing substantial intercalation with ions.

117. The device of claim 88, wherein the first electrochemical electrode undergoes predominately non-faradaic charging and the second electrochemical electrode undergoes predominately faradaic charging during normal device operation.

118. The device of claim 88, the device comprising at least one electrolyte within the ion conducting path between said first and said second electrochemical electrode, wherein said electrolyte is selected from the group consisting of an aqueous salt solution of an alkali metal cation and a halogen anion, a polymeric solid-state electrolyte, an ionic liquid in a polymer matrix, an aqueous solution of sulfuric acid having a molar concentration at least about 4, an aqueous KOH solution having a molar concentration at least about 4, and combinations thereof.

119. The device of claim 88, wherein said first electrochemical electrode additionally comprises a faradaic component that undergoes predominately faradaic charging by intercalation during device operation to achieve an intercalated state,

wherein the intercalated state is electronically conducting, wherein said electrode component C of the said first electrochemical electrode contacts this faradaic component, and wherein said electrode component C of the said first electrochemical electrode has a void volume of at least about 20%.

120. The device of claim 119, wherein said electrode component C has a void volume of at least about 50%.

121. The device of claim 120, wherein said electrode component C has a void volume of at least about 75%.

122. The device of claim 88, wherein said first electrochemical electrode comprises a faradaic component that undergoes predominately faradaic charging by intercalation during device operation to achieve an intercalated state, wherein the intercalated state is electronically conducting, wherein said electrode component C of the said first electrochemical electrode contacts this faradaic component, and wherein a solid-state electrolyte contacts this faradaic component.

123. The device of claim 122, wherein the faradaic component is selected from the group consisting of an organic polymer, a sheet-containing material, a nanofiber-containing material, and combinations thereof.

124. The device of claim 122, wherein the second electrochemical electrode has at least about two times the surface area of the said first electrochemical electrode.

125. The device of claim 124, wherein the second electrochemical electrode has at least about ten times the surface area of the said first electrochemical electrode.

126. The device of claim 89, wherein said device is operable for converting electrical energy to mechanical energy, and wherein at least partially reversible mechanical displacement results from charge injection into electrode component C.

127. The device of claim 89, wherein said device derives function, at least in part, from the electrochemical potential change of electrode component C in response to an applied stress.

128. The device of claim 89, wherein the device is operable for regulating thermal conductivity in a reversible manner by tuning the degree of double-layer charge injection in electrode regions that are not in direct contact with an electrolyte.

129. The device of claim 89, wherein the device is operable for use as a fuel cell, and wherein fuel cell redox reactions occur at electrode component C in the substantial absence of contacting electrolyte.

130. The device of claim 129, wherein electrode component C comprises a catalyst and electrode component C is separated from the second electrochemical electrode by an organic solid-state ionic conductor having low permeability for the fuel components used for fuel cell operation.

131. The device of claim 130, wherein electrode component C further comprises carbon nanotubes.

132. The device of claim 130, further comprising a hydrogen ion transmissive material that is electronically conducting and makes electrical contact with electrode component C.

133. The device of claim 132, wherein said hydrogen ion transmissive material is an electronically conducting organic polymer.

134. The device of claim 89, wherein the device uses double layer charge injection to controllably vary properties selected from the group consisting of magnetic properties, superconducting properties, and combinations thereof.

135. The device of claim 134, wherein the device uses charge-injection-based tuning of magnetic properties.

136. The device of claim 135, wherein the charge-injection-based tuning of magnetic properties is used to switch electronic devices.

137. The device of claim 89, wherein the device is operable for use as an optical sensor selected from the group consisting of a surface-enhanced Raman sensor, an optical transmission based sensor, an optical absorption based sensor, a fluorescent-based sensor, and combinations thereof, and wherein charge injection in the absence of contacting electrolyte is used to provide a tunable sensor response.

138. The device of claim 137, wherein heating selected from the group consisting of electrical heating, optical heating, and combinations thereof, is used to enhance the desorption of sensed materials.

139. The device of claim 137, wherein the tuned sensor response is provided by an electronically conducting photonic crystal.

140. The device of claim 139, wherein the electronically conducting photonic crystal is contacted, but not entirely filled, with an electrolyte.

141. The device of claim 139, wherein the electronically conducting photonic crystal has a void volume of above 50%.

142. The device of claim 139, wherein the photonic crystal comprises metal.
143. The device of claim 142, wherein the metal comprises silver.
144. The device of claim 139, wherein both the working and counter electrodes comprise a photonic crystal.
145. The device of claim 137, wherein the device is operable for sensing materials selected from the group consisting of gases, gas-carried materials, and combinations thereof.
146. The device of claim 89, wherein the device is operable for providing a tunable change in optical properties at wavelengths where the atmosphere is transmissive, wherein such optical properties are selected from the group consisting of transparency, reflectivity, and combinations thereof.
147. The device of claim 89, wherein the device is operable for providing a tunable change in optical properties at wavelengths where the atmosphere is transmissive, wherein such optical properties are selected from the group consisting of transparency, reflectivity, and combinations thereof.
148. The device of claim 89, wherein the device is operable for converting energy in a manner selected from the group consisting of converting thermal energy to electrical energy; creating a temperature difference using the thermoelectric effect, and combinations thereof; wherein electrode component C comprises a porous thermoelectric, wherein the electrode component C is substantially not contacted by electrolyte, and wherein non-faradaic charge injection in electrode component C is used to optimize thermoelectric efficiency.
149. The device of claim 88, further comprising a third electrochemical electrode, wherein the first, second, and third electrochemical electrodes are charged during device operation.
150. The device of claim 88, further comprising a reference electrode.
151. The device of claim 88, wherein the shortest length path for ion transport between the first and second electrochemical electrodes is at most about 1000 microns.
152. The device of claim 151, wherein the shortest length path is at most about 100 microns.
153. The device of claim 152, wherein the shortest length path is at most about 10 microns.

154. The device of claim 88, wherein the first electrochemical electrode has a microscopic dimension.

155. The device of claim 154, wherein said first electrochemical electrode comprises a single nanofiber or nanofiber bundle that is at most about 80 nm in largest diameter.

156. The device of claim 89, wherein the device is operable for use as a chemical sensor, and wherein a gas phase chemical component is sensed, at least in part, by a change in the resistance of an electrode component C.

157. The device of claim 89, wherein the device is operable for use as a gas sensor, and wherein a gas phase component is sensed at least in part by measuring the current between said first electrochemical electrode and said second electrochemical electrode as a function of the potential of said electrode component C.

158. The device of claim 89, wherein the device is operable for use as a chemical sensor, and wherein electrode component C is a channel of an electrochemical transistor.

159. The device of claim 158, wherein electrode component C is the channel of an transistor that can be simultaneously addressed using both electrochemical and dielectric-based charge injection.

160. The device of claim 158, wherein the channel comprises species selected from the group consisting of DNA, RNA, a polypeptide, and combinations thereof.

161. The device of claim 157, further comprising a solid-state electrolyte and a reference electrode inserted in an electrolyte, wherein the potential of said electrode component C is measured with respect to the reference electrode during device operation.

162. The device of claim 89, wherein the device is operable for use as a biochemical sensor, and wherein component C comprises a biochemically active agent.

163. The device of claim 162, wherein the biochemically active agent comprises species selected from the group consisting of DNA, RNA, polypeptides, and combinations thereof.

164. The device of claim 88, wherein the device comprises at least two electrical contacts to the first electrical electrode, and wherein said electrical contacts enable

the passage of sufficient current along said nanostructured electrode component C to increase the rate of non-faradaic charging or discharging of electrode component C.

165. The device of claim 164, further comprising at least two electrical contacts to said second electrode that enables the passage of current between these contacts.

166. A supercapacitor/battery hybrid energy storage device comprising at least one first sheet of a high surface area material that is predominately non-faradaically charged and a second sheet of a material that is predominately faradaically charged, wherein these sheets are laterally joined together to make a device electrode, and wherein the gravimetric surface area of the first sheet is at least about 10 times that of the second sheet.

167. The supercapacitor/battery hybrid energy storage device of claim 166, wherein the device is in a dry state, and wherein there is no complete ion path in an electrolyte between said electrode and a counter electrode.

168. The device of claim 89 wherein the device is operable for use as a regulator of membrane transport, wherein the device comprises a working electrode and a counter electrode, and wherein the application of a potential between these electrodes causes predominately non-faradaic charging of membrane pores and resultant regulation of membrane transport.

169. The device of claim 168, wherein said membrane provides a function selected from the group consisting of containing a drug within its pores, separating a drug from a desired delivery location, and combinations thereof.

170. The device of claim 89, wherein the device is operable for use as an electron emission device, and wherein the nanostructured electrode component C comprises a nanofiber.

171. The device of claim 89, wherein the device is operable for use as an electron emission device, and wherein the device is operable for use as a cold cathode in devices selected from the group consisting of a flat panel display, a lighting fixture, an electron microscope, a discharge tube for over-voltage protection, and combinations thereof.

172. The device of claim 170, wherein electrochemical charge injection into said nanofiber causes a variation in field emission.

173. The device of claim 172, wherein said nanofiber is a nanotube that is opened in a region selected from the group consisting of an end region, a side wall region, and combinations thereof.

174. The device of claim 173, wherein the nanotube is electronically contacted with an electronically conducting material that is intercalated with ions, and wherein the open region is located in a material comprising mobile ions that are sufficiently small in size so as to be capable of fitting inside said nanotube.

175. The device of claim 173, wherein the nanotube changes field emission properties as a result of electrochemically inserting ions inside the volume of said nanotube.

176. The device of claim 175, wherein the ions electrochemically inserted in the nanotube are at least 10 times more numerous than those electrochemically deposited on the exterior surface of said nanotube.

177. The device of claim 88, wherein the means of providing a voltage between said first and said second electrochemical electrodes is provided, at least in part, by an electron beam that contacts said nanostructured electrode component C.

178. The device of claim 177, wherein the device comprises an array of nanostructured electrode components C that are not directly electronically interconnected, and wherein the nanostructured electrode components C are contacted with a solid state electrolyte.

179. The device of claim 178, wherein the device is operable for assembling nano-size objects.

180. The device of claim 88, wherein the device is operable for obtaining electronically tunable thermal conductivity.

181. The device of claim 88, wherein the device is operable for material adsorption, wherein nanostructured electrode component C is used for adsorbing a material and wherein the adsorption of this material is changeable by using a potential change to vary the degree of charge injection in C.

182. The device of claim 181, wherein the material adsorbed comprises hydrogen.

183. The device of claim 88, wherein said nanostructured electrode component C of a first electrochemical electrode and said electrode component D of a second electrochemical electrode are the same element and this element is semiconducting before charge injection.

184. The device of claim 183, wherein opposite ends of said same element are electrochemically charge injected with opposite sign electronic charge during device operation.

185. The device of claim 183, wherein the device is operable for light emission, and wherein the device emits light as a result of the recombination of holes and *electrons in the said same element*.

186. The device of claim 185, wherein said same element has at least approximately parallel sides that have larger area than other sides, wherein an electrolyte contacts one of said parallel sides, and wherein light emission occurs through this electrolyte-contacted side.

187. The device of claim 186, wherein light emission occurs as a result of applying a potential in a direction that is substantially parallel to the said at least approximately parallel sides.

188. The device of claim 185, wherein the light-emitting element is predominately charged non-faradaically in light-emitting regions.

189. The device of claim 185, wherein the device further comprises a second current-carrying electrode, and wherein said second current carrying electrode functions to assist in electrochemical charge injection in the light-emitting element.

190. The device of claim 89, wherein the device is operable for use as an ion emission device, and wherein ions injected electrochemically into electrode component C are emitted into an environment selected from the group consisting of a vacuum and a gas, as a result of a voltage applied between C and a counter-electrode.

191. The device of claim 158, wherein the device comprises at least two channel elements, and wherein these channel elements undergo double-layer based charge injection during device operation.

192. The process of claim 1, wherein the article A is an aerogel.

193. The composition of claim 74, wherein the composition comprises an aerogel.

194. The device of claim 88, wherein said first electrochemical electrode and said second electrochemical electrode are both porous electrodes having a capacitance of at least about 0.1 F/g, and wherein said ionically conducting material that is substantially electronically non-conducting at least partially penetrates both said first and said second electrochemical electrodes.

195. The device of claim 138, wherein the heating is used to characterize the sensed material via measurement of the rate of desorption.